Stabilization Technologies

U.S. Department of Energy
Office of Environmental Management
Office of Science and Technology

Problem

Throughout the Department of Energy (DOE) complex there are large inventories of homogeneous mixed waste solids, such as wastewater treatment residues, fly ashes, and sludges that contain relatively high concentrations of salts. The inherent solubility of salts (e.g., nitrates, chlorides and sulfates) makes traditional treatment of these waste streams difficult, expensive, and challenging. Many of these materials are in a dry granular form and are the by-product of solidifying spent acidic and metal solutions used to recover and reformulate nuclear weapons materials over the past 50 years. Current estimates indicate that over 200 million kg of contaminated salt wastes currently exist at DOE sites. Continued operations involving wastewater treatment facilities and mixed waste incinerators could generate an additional 5 million kg a year.

Solution

One of the obvious treatment solutions is to immobilize the hazardous components in the salt-containing mixed waste to meet Environmental Protection Agency/Resource Conservation and Recovery Act (RCRA) Land Disposal Restrictions, thus reducing waste to a radioactive waste classification only. One proposed solution is to use thermal treatment via vitrification to immobilize the hazardous component and thereby substantially reduce the volume, as well as provide exceptional durability. However, these melter systems involve expensive capital apparatus with complicated offgas systems and generate secondary mixed wastes. In addition, the vitrification of high salt wastes may cause foaming and usually requires extensive development to specify glass formulation recipes. As an alternative to thermal treatments, stabilization of these materials in cementitious grouts has also been widely employed. However, salts interfere with the basic hydration reactions of cement, leading to an inadequate set or deterioration of the waste form over time.

Sufficient and compliant stabilization in cement can be achieved by lowering waste loadings, but this involves a large and costly increase in the volume of material requiring handling, transporting, and disposal. As a consequence of these stabilization deficiencies associated with salt containing mixed wastes, the Mixed Waste Focus Area (MWFA) sponsored the development of several low-temperature stabilization methods as an alternative to cement grouting.

Overall Benefits

The cement-based stabilization alternatives that have been developed for salt-containing mixed waste have the following comprehensive benefits:

- No secondary waste is generated
- Inexpensive off-the-shelf equipment is utilized
- No offgas is generated
- More efficient waste loadings for large waste volumes is achieved
- Significant cost savings over cements are possible

The following selected Environmental Management Office of Science and Technology MWFA-sponsored technologies have enhanced the salt-containing mixed waste stabilization capabilities in the DOE complex. The technologies include both new methods of stabilization as well as a method to deploy stabilization.

Kinetic Mixer

OST/TMS ID 2160

Kinetic processing uses high shear and rapid rotational mixing to create frictional heat sufficient to melt thermoplastic materials. A batch, consisting of plastic materials combined with filler (e.g., waste) material and mixed waste is charged into the mixer and brought to melt temperature in 10 - 20 seconds. This process flashes off moisture and volatile materials, and the resultant waste form is discharged as a homogeneous molten mass. This process uses a novel mixing mechanism to thoroughly homogenize the feed waste with the polymer, while removing the moisture and organics.

Specific Benefits:

- Allows wet wastes and waste-containing organics to be stabilized in polyethylene, thereby increasing the applicability of this stabilization/solidification treatment method

Polymer Microencapsulation

OST/TMS ID 166

The Polymer Microencapsulation processes use polyethylene, epoxies, and other polymers to immobilize wastes. Small particulate, powdered or granular wastes are microencapsulated by blending with molten polyethylene. The blending process thoroughly homogenizes the waste into the molten polymer.

Specific Benefits:

- Provides improved waste form performance
- Results in reduced risk to human health and the environment

Stabilized Contaminants Using the Envirocare Polymer Macroencapsulation

OST/TMS ID 30

Macroencapsulation involves heating and pouring low-density polyethylene into a specially designed container partially filled with pieces of a solid contaminated waste such as lead or debris. The plastic flows around, over, and between pieces of waste, coating and bonding to all surfaces of the waste matrix and thus stabilizing the waste for disposal or safe storage.

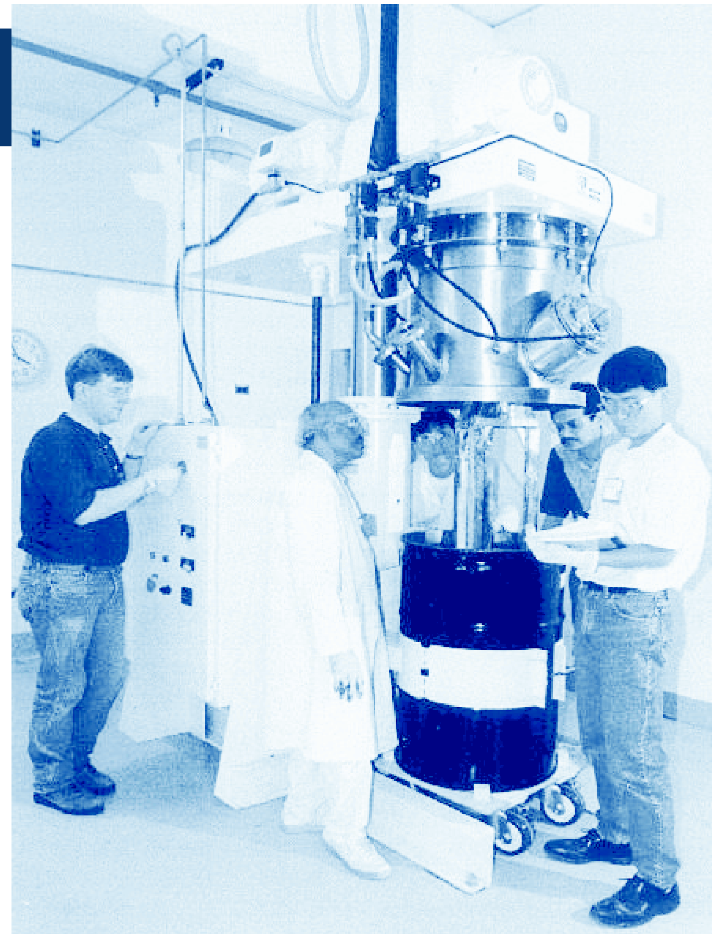
Specific Benefits:

- Simple technology
- Low temperature

Stabilization Using Phosphate Bonded Ceramics

OST/TMS ID 117

In the Chemically Bonded Phosphate Ceramic (CBPC) process, calcined magnesium is reacted with phosphoric acid or acid phosphates to form a uniform ceramic matrix that is capable of stabilizing wastes with salts, hazardous metals, and some organics. CBPC stabilization, although slightly exothermic, occurs at room temperature, minimizing volatilization and offgas emissions.



Specific Benefits:

- Produces durable non-leachable ceramics from mixed low-level waste streams not treatable by thermal methods without generating secondary waste streams
- The hazardous metal phosphate salts formed are insoluble, increasing the leachability resistance of these RCRA metals
- Processable into a solid at room temperature, minimizing risk of volatilization
- For specific application the CBPC process increases the waste loading of mixed waste fly ash and salt-containing mixed wastes over that produced with traditional cement grouting techniques; this in turn will reduce costs

In addition to the technologies specifically described above, additional stabilization methods have been developed by the Office of Science and Technology and demonstrated for the purpose of improving the performance for waste forms containing troublesome waste. These methods include enhanced cementitious processes, sol-gel techniques, polyesters, polysiloxane, and sulfur polymer cement. Details on the specifics of these mixed waste stabilization/solidification methods have been published in a series of Innovative Technology Summary Reports (ITSRs). These ITSRs are available through the following web site:

http://wastenot.inel.gov/mwfa/sadoc.html

For more information

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Mixed Waste Focus Area home page:
http://wastenot.inel.gov/mwfa/index.html

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2000.001
2/16/2000